WEST Search History

DATE: Tuesday, April 02, 2002

Set Name side by side	Query	Hit Count	Set Name result set
	DB=USPT,PGPB,JPAB,EPAB,DWPI,TDBD; PLUR=YES; OP=OR		
L10	L9 not l2	15	L10
L9	L7 and ((705/37)!.CCLS.)	115	L9
L8	L7 ((705/37)!.CCLS.)	767	L8
L7	(specif$ or design$ or select$ or format$ or template) near3 auction$	367	L7
L6	(specif$ or design$ or select$ or format$ or template) near3 auction$	367	L6
L5	(specif$ or design$ or select$ or format$ or template) near3 auction$	367	L5
L4	(specif$ or design$ or select$ or format$ or template) near3 auction$	347	L4
L3	(specif$ or design$ or select$ or format$ or template) near3 auction$	309	L3
L2	L1 and ((705/37)!.CCLS.)	100	L2
L1	(specif$ or design$ or select$ or format$ or template) near3 auction$	309	L1

END OF SEARCH HISTORY

REVIEWED TI/AB.

```
Set     Items   Description
S1          1   ((AUCTIONBOT OR CASBA) AND AUCTION?)
File  15:ABI/Inform(R) 1971-2002/Apr 01
         (c) 2002 ProQuest Info&Learning
File   9:Business & Industry(R) Jul/1994-2002/Mar 29
         (c) 2002 Resp. DB Svcs.
File 623:Business Week 1985-2002/Apr 01
         (c) 2002 The McGraw-Hill Companies Inc
File 810:Business Wire 1986-1999/Feb 28
         (c) 1999 Business Wire
File 275:Gale Group Computer DB(TM) 1983-2002/Apr 01
         (c) 2002 The Gale Group
File 624:McGraw-Hill Publications 1985-2002/Apr 02
         (c) 2002 McGraw-Hill Co. Inc
?
```

WEST

Classification Search

Database to Search: US Patents Full-Text Database; US Pre-Grant Publication Full-Text Database; JPO Abstracts Database; EPO Abstracts Database; Derwent World Patents Index; IBM Technical Disclosure Bulletins

Classification System: No Classifications Available

Classification(s):

Display: 30 **Documents in** **Display Format:** - **Starting With #:** 1

Generate: ○ Hit List ◉ Hit Count ○ Side by Side ○ Image

Search | Clear | Interrupt | Help | Logout

Main Menu | Show S Numbers | Edit S Numbers | Preferences | Cases

Search History

DATE: Tuesday, April 02, 2002 Printable Copy Create Case

Set Name side by side	Query	Hit Count	Set Name result set
DB=USPT,PGPB,JPAB,EPAB,DWPI,TDBD; PLUR=YES; OP=OR			
L1	((705/37)!.COR.)	327	L1

END OF SEARCH HISTORY

REVIEWED
TI/AB

WEST Search History

DATE: Tuesday, April 02, 2002

Set Name side by side	Query	Hit Count	Set Name result set
	DB=USPT,PGPB,JPAB,EPAB,DWPI,TDBD; PLUR=YES; OP=OR		
L8	l3 and (commodities adj futures)	5	L8
L7	L4 and commodit$	11	L7
L6	L5 and commodit$	186	L6
L5	L3 and commodit$	186	L5
L4	L3 and auction	28	L4
L3	(sampl$ or example or model or test) adj (qualit$ or assay or value or valuation or apprais$)	47913	L3
L2	(sampl$ or example or model or test) adj (qualit$ or assay or value or valuation or apprais$)	45822	L2
L1	(sampl$ or example or model or test) adj (qualit$ or assay or value or valuation or apprais$)	45752	L1

END OF SEARCH HISTORY

O = Retrieved
T2/AB

T 1/9/1

1/9/1 (Item 1 from file: 15)
DIALOG(R)File 15:ABI/Inform(R)

01784422 04-35413
Agents that buy and sell
Maes, Pattie; Guttman, Robert H; Moukas, Alexandros G
Communications of the ACM v42n3 PP: 81-87+ Mar 1999 ISSN: 0001-0782
JRNL CODE: ACM
DOC TYPE: Journal article LANGUAGE: English LENGTH: 9 Pages
SPECIAL FEATURE: Charts References
WORD COUNT: 3337

ABSTRACT: Popular software agents that were first used several years ago to filter information, match people with similar interests and automate repetitive behavior. More recently, agents have been applied to electronic commerce, promising a revolution in the way we conduct transactions - business-to-business, business-to-consumer and consumer-to-consumer. The Internet and World Wide Web represent an increasingly important channel for retail commerce as business-to-business transactions. Recent studies have found that the numbers of people buying, selling and forming transactions on the Web are increasing at a phenomenal rate. However, the potential of the Internet for transforming commerce is largely unrealized. Electronic purchases are still largely nonautomated. How software agent technologies can be used to automate several of the most time-consuming stages of the buying process is discussed.

TEXT: Headnote:

Shoppers and sellers alike dispatch them into the digital bazaar to autonomously represent their best interests.

POPULAR SOFTWARE AGENTS WERE FIRST USED SEVERAL YEARS ago to filter information, match people with similar interests, and automate repetitive behavior. More recently, agents have been applied to e-commerce, promising a revolution in the way we conduct transactions-business-to-business, business-to-consumer, and consumer-to-consumer. The Internet and World-Wide Web represent an increasingly important channel for retail commerce as well as business-tobusiness transactions. Recent studies by Forrester Research, International Data Corp., and Nielsen Media Research, have found that the numbers of people buying,

selling, and performing transactions on the Web are increasing at a phenomenal pace. However, the potential of the Internet for transforming commerce is largely unrealized. Electronic purchases are still largely nonautomated. While information about products and vendors is more easily accessible, and orders and payments are dealt with electronically, humans are still in the loop in all stages of the buying process, adding to transaction costs. A human buyer is still responsible for collecting and interpreting information on merchants and prod- ucts, making decisions about merchants and products, and ultimately entering purchase and payment information.

Software agent technologies can be used to automate several of the most time-consuming stages of the buying process. Unlike socalled traditional software, software agents are personalized, continuously running, and semiautonomous [1]. These qualities help optimize the whole buying experience, revolutionizing commerce as we know it [2]. For example, a company that needs to order paper supplies could enlist agents to monitor the quantity and usage patterns of paper within the company, launching buying agents when supplies are low. Buying agents automatically collect information on vendors and products that may fit the needs of the company, evaluate the various offerings, make a decision on which merchants and

products to investigate, negotiate the terms of transactions with these merchants, and finally place orders and make automated payments.

As Mediators in E-commerce

It is useful to use a common framework as a context for exploring the roles of agents as mediators in ecommerce. The model we use here stems from consumer buying behavior (CBB) research and includes the actions and decisions involved in buying and using goods and services. Although CBB covers many areas, it is important to recognize its limitations. For example, CBB research focuses primarily on retail markets (although most of its concepts pertain to business-to-business and consumer-to-consumer markets). Even within retail, not all shopping behaviors are captured (such as impulse purchasing). Moreover, e-commerce covers a broad range of issues, some beyond the scope of a CBB model (such as back-office management, supply chain management, and other merchant issues).

Several descriptive theories and models seek to capture buying behavior, including the Nicosia model, the HowardSheth model, the Engel-Blackwell model, the Bettman information-processing model, and the Andreasen model. All share six similar fundamental stages of the buying process:

Need identification. Characterizes the buyer becoming aware of some unmet need. The buyer can be motivated through product information.

Product brokering. Includes retrieval of information to help determine what to buy. Information retrieval includes an evaluation of product alternatives based on buyer-provided criteria. The result is the "consideration set" of products.

Merchant brokering. Combines the "consideration set" from the previous stage with merchant-specific information to help determine who to buy from. This stage also includes evaluation of merchant alternatives based on buyer-provided criteria (such as price, warranty, availability, delivery time, and reputation).

Negotiation. Considers how to settle on the terms of a transaction. Negotiation varies in duration and complexity depending on the market. In traditional retail markets, prices and other aspects of a transaction are often fixed, leaving no room for negotiation. In other markets (such as stocks, automobiles, and fine art), the negotiation of price and other aspects of the deal are integral to the buying process.

(Illustration Omitted)

Captioned as: Figure I.

(Table Omitted)

Captioned as: Table I.
Purchase and delivery. Signals either termination of the negotiation stage or occurs sometime afterward (in either order). In some cases, the available payment (such as cash only) or delivery options can influence product and merchant brokering.

Product service and evaluation. Involves post-purchase product service, customer service, and evaluation of the satisfaction of the overall buying experience and decision.

As with most models, these stages represent an approximation and simplification of complex behaviors. They often overlap, and migration from one to another can be nonlinear and iterative.

They also help identify where agent technologies apply to the shopping experience, allowing us to more formally categorize existing agent-mediated

e-commerce systems [3]. We can, for example, identify the roles of agents as mediators in e-commerce. The personalized, continuously running, autonomous nature of agents makes them well-suited for mediating consumer behaviors involving information filtering and retrieval, personalized evaluations, complex coordination, and time-based interactions. These roles correspond most notably to need identification, product brokering, merchant brokering, and negotiation in the buying behavior model. Table 1 lists the six buying behavior stages and which of them are supported by representative agent systems.

To some extent, agent technology can be helpful in automating or assisting the buyer with the need-identification stage. Specifically, agents can help in purchases that are repetitive (such as supplies) or predictable (such as habits). One of the oldest and simplest examples of software agents are so-called monitors, or continuously running programs that monitor a set of sensors or data streams and take actions when certain prespecified conditions apply. Examples are abundant in the stock market, as well as at e-commerce sites. For example, Amazon.com offers its customers a "notification agent" called "Eyes" that monitors its catalog of books and notifies the customer when certain events occur that may be of interest, like when a new book by a particular author becomes available or when a new book in a certain category becomes available.

After identifying a need to buy something (possibly with the assistance of a monitor agent), the buyer has to determine what to buy through a critical evaluation of retrieved product information. Table 1 lists several agent systems-PersonaLogic, Firefly, and Tete-aTete-that lower consumers' search costs when deciding which products best meet their needs. PersonaLogic (www.personalogic.com) enables consumers to narrow the list of products that best meet their needs by helping them define a number of product features. The system filters out unwanted products within a given domain after a shopper specifies constraints on product features. A constraint-satisfaction engine then returns a list of products that satisfy all of the shopper's hard constraints in order of how well they satisfy the shopper's soft constraints.

Tete-a-Tete uses comparable techniques to recommend complex products based on multiattribute utility theory. However, unlike PersonaLogic, Tete-a-Tete also assists buyers and sellers in the merchant-brokering and negotiation stages.

Like PersonaLogic, Firefly (www.firefly.com) and other systems based on collaborative filtering [4] help consumers find products (see Figure 1). However, instead of filtering products based on features, Firefly recommends products through an automated "wordof-mouth" recommendation mechanism called "collaborative filtering." The system first compares a shopper's product ratings with those of other shoppers. After identifying the shopper's "nearest neighbors," or users with similar taste, the system recommends the products the neighbors rated highly but which the shopper may not yet have rated, possibly resulting in serendipitous finds. Firefly uses the opinions of like-minded people to offer recommendations of such commodity products as music and books, as well as more-difficult-to-characterize products, such as Web pages and restaurants.

In addition to constraint-based and collaborative filtering techniques, two other techniques are widely used to implement product brokering and productrecommendation agents. A large set of sites uses simple rule-based techniques, such as those provided by Broadvision, Inc., to personalize product offerings for individual customers. A few sites experiment with data-mining techniques to discover patterns in customer purchasing behavior, exploiting these patterns to help customers find other products that meet their needs.

Whereas the product brokering stage compares product alternatives, the merchant-brokering stage compares merchant alternatives. Andersen

Consulting's BargainFinder (bf.cstar.ac. com/bf) is the first shopping agent for online price comparisons. Given a specific product, BargainFinder looks up its price from at least nine different merchant Web sites using Web-browser-like requests. Although a limited proofof-concept system, BargainFinder offers valuable insight into the issues involved in price comparisons in the online world. For example, a third of the online CD merchants accessed by BargainFinder blocked all of its price requests. One reason was that many merchants don't want to compete on price alone. Value-added services offered on merchants Web sites were being bypassed by BargainFinder and therefore not likely considered in the consumer's buying decision. However, Andersen Consulting also received requests from an equal number of smaller merchants who wanted to be included in BargainFinder's price comparison. In short, companies competing on price and welcoming exposure wanted to be included; the others didn't.

Jango (jango.excite.com) can be viewed as an advanced BargainFinder (see Figure 2). The original Jango version "solved" the merchant-blocking issue by having the product requests originate from each consumer's Web browser instead of from a central site, as in BargainFinder. This way, requests to merchants from a Jango-augmented Web browser appeared as requests from "real" customers. Such aggressive interoperability makes it convenient for consumers to compare prices from a number of merchants' online catalogs, whether or not merchants welcome such comparisons. While virtual database technology (such as that offered by Junglee, Inc.) and learning techniques for semiautomatically composing "wrappers" for Web sites [5] are helpful for building comparison shopping agents, the process is still done largely by hand and is extremely tedious. In the near future, XML (see Glushko et al.'s article in this issue) as well as mobile agents technology (see Wong et al.'s article in this issue) may make comparisonshopping agents a lot more flexible, open-ended, and easier to implement.
During the negotiation stage, participants settle on price or other terms of the transaction. Most business-to-business transactions involve negotiation (see Sandholm's "Automated Negotiation" in this issue). In retail, we are familiar mostly with fixed prices, even though fixed-price selling was introduced only about 100 years ago. The benefit of dynamically negotiating a price for a product instead of fixing it is that the merchant is relieved from having to determine-a priori-the value of the good. Rather, this burden is pushed into the marketplace. As a result, limited resources are allocated fairly, that is, to those who value them most. However, there are impediments to using negotiation. In the physical world, certain types of auctions require all parties to be geographically colocated in, say, an auction house. Negotiating may also be too complicated or frustrating for the average consumer. Moreover, some negotiation protocols perform over an extended period of time that does not suit impatient or time-constrained consumers. In general, real-world negotiations accrue transaction costs that may be too high for either consumers or merchants.

(Graph Omitted)

Captioned as: Figure 2.
(Graph Omitted)

Captioned as: Figure 3. Figure 4.

Many of these impediments disappear in the digital world. For example, OnSale (www.onsale.com) and eBay'sAuctionWeb(www.ebay.com/aw) are two popular Web sites selling refurbished and secondhand products through a choice of auction protocols. Unlike physical□auction□houses, these sites do not require participants to be colocated geographically. However, these sites still require consumers to manage their own negotiation strategies over an extended period-and is where agent technologies come in. Table 1 lists several agent systems-AuctionBot, Kasbah, and Tete-a-Tete-that assist customers negotiating the terms of a transaction.

AuctionBot (□auction□.eecs.umich. edu) is a generalpurpose Internet auction server at the University of Michigan. Its users create new auctions by choosing from a selection of □auction□ types and then specifying its parameters (such as clearing times, method for resolving tie bids, and number of sellers permitted) (see Figure 3). Buyers and sellers can then bid according to the auction's multilateral distributive negotiation protocols. In a typical scenario, a seller bids a reservation price after creating theauctionand lets□AuctionBot□manage and enforce buyer bidding according to theauction 's protocols and parameters. What makes AuctionBot different from most other□auction□sites, however, is that it provides an application programming interface for users to create their own software agents to autonomously compete in theAuctionBot marketplace. However, as with the Fishmarket Project [6], users encode their own bidding strategies. Fishmarket is not currently being used as a real-world system, but it has hosted tournaments for comparing opponents' handcrafted bidding strategies along the lines of Axelrod's prisoner's dilemma tournaments [7].

(Graph Omitted)

Captioned as: Figure

MIT Media Lab's Kasbah (kasbah.media.mit.edu) [8] is an online, multiagent consumer-to-consumer transaction system. Users who want to buy or sell an item create an agent, give it some strategic direction, and send it off into a centralized agent marketplace (see Figure 4). Kasbah agents proactively seek out potential buyers or sellers and negotiate with them on behalf of their owners. Each agent's goal is to complete an acceptable deal on behalf of its usersubject to a set of user-specified constraints, such as initial asking (or bidding) price, a lowest (or highest) acceptable price, a date by which to complete the transaction, and restrictions on which parties to negotiate with and how to change the price over time. Kasbah's agents automate much of the merchant-brokering and negotiation stages for both buyers and sellers.

Negotiation in Kasbah is straightforward. After buying agents and selling agents are matched, the only valid action in the negotiation protocol is for buying agents to offer a bid to selling agents with no restrictions on time or price. Selling agents respond with either a binding "yes" or "no." Given this protocol, Kasbah provides buyers with one of three negotiation strategies: anxious, cool-headed, and frugal-corresponding to a linear, quadratic, and exponential function respectively for increasing its bid for a product over time (similar functions exist for selling agents). The simplicity of these negotiation heuristics makes it intuitive for users to understand what their agents are doing in the marketplace. This understanding is important for user acceptance, as observed in a recent Media Lab experiment [8]. A larger Kasbah experiment now under way at MIT allows students to buy and sell books and music.

The Kasbah system also incorporates a trust and reputation mechanism called the "better business bureau." Upon completion of a transaction, both parties may rate how well their counterpart managed his or her half of the deal (such as for accuracy of product condition and completion of transaction). Kasbah agents use accumulated ratings to determine whether they should negotiate with agents whose owners fall below a user-specified reputation threshold. More details on the specific algorithms used in Kasbah's better business bureau are in [9]. Tete-a-Tete (ecommerce.media.mit.edu/tete-atete/) [10] provides a unique negotiation approach to retail sales. Unlike most other online negotiation systems that competitively negotiate over price, Tete-aTete's consumer-owned shopping agents and merchant-owned sales agents cooperatively negotiate across multiple terms of a transaction, including warranties, delivery times, service contracts, return policies, loan options, gift services, and other merchant value-added services. Based on bilateral argumentation [11], Tete-a-Tete's integrative negotiations comprise an exchange of XML-based

proposals, critiques, and counterproposals. For example, a shopping agent may receive proposals from multiple sales agents. Each one defines a complete product offering, including a product's configuration and price and the merchant's value-added services. The shopping agent evaluates and orders these proposals based on how well they satisfy its owner's preferences (expressed as multiattribute utilities) (see Figure 5). Shoppers dissatisfied with the proposals can critique them along one or more dimensions. The shopper agent broadcasts these preference changes to the sales agents that, in turn, use them to counterpropose better product offerings.

Tete-a-Tete considers product features and merchant features equally throughout negotiations to help the shopper simultaneously determine what to buy and whom to buy from. This integration of product and merchant brokering through integrative negotiations enables constraints on product features to influence the decision of whom to buy from. For example, only a certain merchant may provide a particular product configuration. Likewise, constraints on merchant features can influence the decision of what to buy. So, if no merchant can accommodate the overnight delivery of a specific product, an alternate product that can be delivered overnight may be deemed a better overall value.

Future Directions

Software agents are helping buyers and sellers combat information overload and expedite specific stages of the online buying process. Today's first-generation agent-mediated e-commerce systems are already creating new markets (such as low-cost consumer-to-consumer goods) and beginning to reduce transaction costs in a variety of business processes. The industries affected first are those dealing with perishables (such as travel, theater and concert tickets, and network bandwidth availability), and surplus inventory and commodities (such as gas, electricity, pencils, music, and books).

However, we still have a way to go before software agents transform the way companies conduct business. This change will occur as agent technologies mature to better manage ambiguous content, personalized preferences, complex goals, changing environments, and disconnected parties. The greatest changes may occur once standards are adopted and resolved to unambiguously and universally define goods and services [10], consumer and merchant profiles, valueadded services, secure payment mechanisms, and interbusiness electronic forms.

Looking even further into the future, agents will explore new types of transactions in the form of dynamic relationships among previously unknown parties. At the speed of bits, agents will strategically form and reform coalitions to bid on contracts and leverage economies of scale-in essence creating dynamic business partnerships that exist only as long as necessary. It is in this third-generation of agentmediated e-commerce that companies will be at their most agile, and marketplaces will approach perfect efficiency

Reference:
REFERENCES

Reference:

1. Maes, P. Agents that reduce work and information overload. Commun. ACM37, 7 (July 1994), 31-40.

2. Moukas, A., Guttman, R, and Maes, P. Agent-mediated electronic commerce: An MIT Media Laboratory perspective. In Proceedings of the International Conference on Electronic Commerce (Seoul, Korea, Apr. 6-9). ICEC, Seoul, 1998, pp. 9-15.

3. Terpsidis, I., Moukas, A., Pergioudakis, B., Doukidis, G., and Maes, P. The Potential of electronic commerce in reengineering consumer-retail relationships through intelligent agents. In Advances in Information Technologies: The Business Challenge, J.-Y. Roger, B. Stanford-Smith, and P. Kidd., Eds., IOS Press, Amsterdam, Denmark, 1997. 4. Shardanand, U., and Maes, P. Social information filtering: Algorithms for automating 'word of mouth.' In Proceedings of the Computer-Human Interaction Conference CHI95 (Denver, Colo., May 7-11). ACM Press, N.Y., pp. 210-217.

Reference:

5. Doorenbos, R., Etzioni, O., and Weld, D. A scalable comparison-shopping agent for the World-Wide Web. In Proceedings of the First International Conference on Autonomous Agents 97 (Marina del Rey, Calif., Feb. 5-8). ACM Press, N.Y., 1997, pp. 3948.

6. Rodriquez, J., Noriega, P., Sierra, C., and Padget, J. FM96.5: A Javabased electronic auction house. In Proceedings of the Second International Conference on the Practical Application of Intelligent Agents and Multi-Agent Technology PAAM'97 (London, U.K., Apr.). Practical Application Company, London, 1997.

7. Axelrod, R. The Evolution of Cooperation. Harper Collins, N.Y., 1984. 8. Chavez, A., Dreilinger, D., Guttman, IL, and Maes, P. A real-life experiment in creating an agent marketplace. In Proceedings of the Second International Conference on the Practical Application of Intelligent Agents and Multi-Agent Technology PAAM97 (London, U.K., Apr.). Practical Application Company, London, 1997.

Reference:

9. Zacharia, G., Moukas, A., and Maes, P. Collaborative reputation mechanisms in electronic marketplaces. In Proceedings of the HICSS-99 Conference, Electronic Commerce Minitrack (Maui, Hawaii, Jan. 5-9). IEEE Computer Society, 1999.

10. Guttman, R., and Maes, P. Agent-mediated integrative negotiation for retail electronic commerce. In Proceedings of the Workshop on Agent-Mediated Electronic Trading AMET 98 (Minneapolis, May 1998). 11. Parsons, S., Sierra, C., and Jennings, N. Agents that reason and negotiate by arguing. J. Log. Comput.

Author Affiliation:

PATTIE MAES (pattie@media.mit.edu) is an associate professor in MITs Media Laboratory where she founded and directs the Software Agents Group.

ROBERT H. GUTTMAN (guttman@media.mit.edu) is a cofounder of Frictionless Commerce, Inc., a start-up building the next generation of shopping advisory solutions for retail e-commerce.

ALEXANDROS G. MOUKAS (moux@media.mit.edu) is a cofounder of Frictionless Commerce, Inc., an AT&T Fellow, and a doctoral candidate in MIT Media Laboratory's Software Agents Group (on leave).

GEOGRAPHIC NAMES: US

DESCRIPTORS: Electronic commerce; Market potential; Intelligent agent; Internet; World Wide Web; Buy sell agreements
CLASSIFICATION CODES: 5250 (CN=Telecommunications systems); 9190 (CN=United States); 7300 (CN=Sales & selling)
?

T 1/9/1

1/9/1 (Item 1 from file: 15)
DIALOG(R)File 15:ABI/Inform(R)

01784422 04-35413
Agents that buy and sell
Maes, Pattie; Guttman, Robert H; Moukas, Alexandros G
Communications of the ACM v42n3 PP: 81-87+ Mar 1999 ISSN: 0001-0782
JRNL CODE: ACM
DOC TYPE: Journal article LANGUAGE: English LENGTH: 9 Pages
SPECIAL FEATURE: Charts References
WORD COUNT: 3337

ABSTRACT: Popular software agents that were first used several years ago to filter information, match people with similar interests and automate repetitive behavior. More recently, agents have been applied to electronic commerce, promising a revolution in the way we conduct transactions - business-to-business, business-to-consumer and consumer-to-consumer. The Internet and World Wide Web represent an increasingly important channel for retail commerce as business-to-business transactions. Recent studies have found that the numbers of people buying, selling and forming transactions on the Web are increasing at a phenomenal rate. However, the potential of the Internet for transforming commerce is largely unrealized. Electronic purchases are still largely nonautomated. How software agent technologies can be used to automate several of the most time-consuming stages of the buying process is discussed.

TEXT: Headnote:

Shoppers and sellers alike dispatch them into the digital bazaar to autonomously represent their best interests.

POPULAR SOFTWARE AGENTS WERE FIRST USED SEVERAL YEARS ago to filter information, match people with similar interests, and automate repetitive behavior. More recently, agents have been applied to e-commerce, promising a revolution in the way we conduct transactions-business-to-business, business-to-consumer, and consumer-to-consumer. The Internet and World-Wide Web represent an increasingly important channel for retail commerce as well as business-tobusiness transactions. Recent studies by Forrester Research, International Data Corp., and Nielsen Media Research, have found that the numbers of people buying,

selling, and performing transactions on the Web are increasing at a phenomenal pace. However, the potential of the Internet for transforming commerce is largely unrealized. Electronic purchases are still largely nonautomated. While information about products and vendors is more easily accessible, and orders and payments are dealt with electronically, humans are still in the loop in all stages of the buying process, adding to transaction costs. A human buyer is still responsible for collecting and interpreting information on merchants and prod- ucts, making decisions about merchants and products, and ultimately entering purchase and payment information.

Software agent technologies can be used to automate several of the most time-consuming stages of the buying process. Unlike socalled traditional software, software agents are personalized, continuously running, and semiautonomous [1]. These qualities help optimize the whole buying experience, revolutionizing commerce as we know it [2]. For example, a company that needs to order paper supplies could enlist agents to monitor the quantity and usage patterns of paper within the company, launching buying agents when supplies are low. Buying agents automatically collect information on vendors and products that may fit the needs of the company, evaluate the various offerings, make a decision on which merchants and

products to investigate, negotiate the terms of transactions with these merchants, and finally place orders and make automated payments.

As Mediators in E-commerce

It is useful to use a common framework as a context for exploring the roles of agents as mediators in ecommerce. The model we use here stems from consumer buying behavior (CBB) research and includes the actions and decisions involved in buying and using goods and services. Although CBB covers many areas, it is important to recognize its limitations. For example, CBB research focuses primarily on retail markets (although most of its concepts pertain to business-to-business and consumer-to-consumer markets). Even within retail, not all shopping behaviors are captured (such as impulse purchasing). Moreover, e-commerce covers a broad range of issues, some beyond the scope of a CBB model (such as back-office management, supply chain management, and other merchant issues).

Several descriptive theories and models seek to capture buying behavior, including the Nicosia model, the HowardSheth model, the Engel-Blackwell model, the Bettman information-processing model, and the Andreasen model. All share six similar fundamental stages of the buying process:

Need identification. Characterizes the buyer becoming aware of some unmet need. The buyer can be motivated through product information.

Product brokering. Includes retrieval of information to help determine what to buy. Information retrieval includes an evaluation of product alternatives based on buyer-provided criteria. The result is the "consideration set" of products.

Merchant brokering. Combines the "consideration set" from the previous stage with merchant-specific information to help determine who to buy from. This stage also includes evaluation of merchant alternatives based on buyer-provided criteria (such as price, warranty, availability, delivery time, and reputation).

Negotiation. Considers how to settle on the terms of a transaction. Negotiation varies in duration and complexity depending on the market. In traditional retail markets, prices and other aspects of a transaction are often fixed, leaving no room for negotiation. In other markets (such as stocks, automobiles, and fine art), the negotiation of price and other aspects of the deal are integral to the buying process.

(Illustration Omitted)

Captioned as: Figure I.

(Table Omitted)

Captioned as: Table I.
Purchase and delivery. Signals either termination of the negotiation stage or occurs sometime afterward (in either order). In some cases, the available payment (such as cash only) or delivery options can influence product and merchant brokering.

Product service and evaluation. Involves post-purchase product service, customer service, and evaluation of the satisfaction of the overall buying experience and decision.

As with most models, these stages represent an approximation and simplification of complex behaviors. They often overlap, and migration from one to another can be nonlinear and iterative.

They also help identify where agent technologies apply to the shopping experience, allowing us to more formally categorize existing agent-mediated

e-commerce systems [3]. We can, for example, identify the roles of agents as mediators in e-commerce. The personalized, continuously running, autonomous nature of agents makes them well-suited for mediating consumer behaviors involving information filtering and retrieval, personalized evaluations, complex coordination, and time-based interactions. These roles correspond most notably to need identification, product brokering, merchant brokering, and negotiation in the buying behavior model. Table 1 lists the six buying behavior stages and which of them are supported by representative agent systems.

To some extent, agent technology can be helpful in automating or assisting the buyer with the need-identification stage. Specifically, agents can help in purchases that are repetitive (such as supplies) or predictable (such as habits). One of the oldest and simplest examples of software agents are so-called monitors, or continuously running programs that monitor a set of sensors or data streams and take actions when certain prespecified conditions apply. Examples are abundant in the stock market, as well as at e-commerce sites. For example, Amazon.com offers its customers a "notification agent" called "Eyes" that monitors its catalog of books and notifies the customer when certain events occur that may be of interest, like when a new book by a particular author becomes available or when a new book in a certain category becomes available.

After identifying a need to buy something (possibly with the assistance of a monitor agent), the buyer has to determine what to buy through a critical evaluation of retrieved product information. Table 1 lists several agent systems-PersonaLogic, Firefly, and Tete-aTete-that lower consumers' search costs when deciding which products best meet their needs. PersonaLogic (www.personalogic.com) enables consumers to narrow the list of products that best meet their needs by helping them define a number of product features. The system filters out unwanted products within a given domain after a shopper specifies constraints on product features. A constraint-satisfaction engine then returns a list of products that satisfy all of the shopper's hard constraints in order of how well they satisfy the shopper's soft constraints.

Tete-a-Tete uses comparable techniques to recommend complex products based on multiattribute utility theory. Howéver, unlike PersonaLogic, Tete-a-Tete also assists buyers and sellers in the merchant-brokering and negotiation stages.

Like PersonaLogic, Firefly (www.firefly.com) and other systems based on collaborative filtering [4] help consumers find products (see Figure 1). However, instead of filtering products based on features, Firefly recommends products through an automated "wordof-mouth" recommendation mechanism called "collaborative filtering." The system first compares a shopper's product ratings with those of other shoppers. After identifying the shopper's "nearest neighbors," or users with similar taste, the system recommends the products the neighbors rated highly but which the shopper may not yet have rated, possibly resulting in serendipitous finds. Firefly uses the opinions of like-minded people to offer recommendations of such commodity products as music and books, as well as more-difficult-to-characterize products, such as Web pages and restaurants.

In addition to constraint-based and collaborative filtering techniques, two other techniques are widely used to implement product brokering and productrecommendation agents. A large set of sites uses simple rule-based techniques, such as those provided by Broadvision, Inc., to personalize product offerings for individual customers. A few sites experiment with data-mining techniques to discover patterns in customer purchasing behavior, exploiting these patterns to help customers find other products that meet their needs.

Whereas the product brokering stage compares product alternatives, the merchant-brokering stage compares merchant alternatives. Andersen

Consulting's BargainFinder (bf.cstar.ac. com/bf) is the first shopping agent for online price comparisons. Given a specific product, BargainFinder looks up its price from at least nine different merchant Web sites using Web-browser-like requests. Although a limited proofof-concept system, BargainFinder offers valuable insight into the issues involved in price comparisons in the online world. For example, a third of the online CD merchants accessed by BargainFinder blocked all of its price requests. One reason was that many merchants don't want to compete on price alone. Value-added services offered on merchants Web sites were being bypassed by BargainFinder and therefore not likely considered in the consumer's buying decision. However, Andersen Consulting also received requests from an equal number of smaller merchants who wanted to be included in BargainFinder's price comparison. In short, companies competing on price and welcoming exposure wanted to be included; the others didn't.

Jango (jango.excite.com) can be viewed as an advanced BargainFinder (see Figure 2). The original Jango version "solved" the merchant-blocking issue by having the product requests originate from each consumer's Web browser instead of from a central site, as in BargainFinder. This way, requests to merchants from a Jango-augmented Web browser appeared as requests from "real" customers. Such aggressive interoperability makes it convenient for consumers to compare prices from a number of merchants' online catalogs, whether or not merchants welcome such comparisons. While virtual database technology (such as that offered by Junglee, Inc.) and learning techniques for semiautomatically composing "wrappers" for Web sites [5] are helpful for building comparison shopping agents, the process is still done largely by hand and is extremely tedious. In the near future, XML (see Glushko et al.'s article in this issue) as well as mobile agents technology (see Wong et al.'s article in this issue) may make comparisonshopping agents a lot more flexible, open-ended, and easier to implement.
During the negotiation stage, participants settle on price or other terms of the transaction. Most business-to-business transactions involve negotiation (see Sandholm's "Automated Negotiation" in this issue). In retail, we are familiar mostly with fixed prices, even though fixed-price selling was introduced only about 100 years ago. The benefit of dynamically negotiating a price for a product instead of fixing it is that the merchant is relieved from having to determine-a priori-the value of the good. Rather, this burden is pushed into the marketplace. As a result, limited resources are allocated fairly, that is, to those who value them most. However, there are impediments to using negotiation. In the physical world, certain types of auctions require all parties to be geographically colocated in, say, an auction house. Negotiating may also be too complicated or frustrating for the average consumer. Moreover, some negotiation protocols perform over an extended period of time that does not suit impatient or time-constrained consumers. In general, real-world negotiations accrue transaction costs that may be too high for either consumers or merchants.

(Graph Omitted)

Captioned as: Figure 2.
(Graph Omitted)

Captioned as: Figure 3. Figure 4.

Many of these impediments disappear in the digital world. For example, OnSale (www.onsale.com) and eBay'sAuctionWeb(www.ebay.com/aw) are two popular Web sites selling refurbished and secondhand products through a choice of auction protocols. Unlike physical□auction□houses, these sites do not require participants to be colocated geographically. However, these sites still require consumers to manage their own negotiation strategies over an extended period-and is where agent technologies come in. Table 1 lists several agent systems-AuctionBot, Kasbah, and Tete-a-Tete-that assist customers negotiating the terms of a transaction.

AuctionBot (□auction□.eecs.umich. edu) is a generalpurpose Internet auction server at the University of Michigan. Its users create new auctions by choosing from a selection of □auction□ types and then specifying its parameters (such as clearing times, method for resolving tie bids, and number of sellers permitted) (see Figure 3). Buyers and sellers can then bid according to the auction's multilateral distributive negotiation protocols. In a typical scenario, a seller bids a reservation price after creating theauctionand lets□AuctionBot□manage and enforce buyer bidding according to theauction 's protocols and parameters. What makes AuctionBot different from most other□auction□sites, however, is that it provides an application programming interface for users to create their own software agents to autonomously compete in theAuctionBot marketplace. However, as with the Fishmarket Project [6], users encode their own bidding strategies. Fishmarket is not currently being used as a real-world system, but it has hosted tournaments for comparing opponents' handcrafted bidding strategies along the lines of Axelrod's prisoner's dilemma tournaments [7].

(Graph Omitted)

Captioned as: Figure

MIT Media Lab's Kasbah (kasbah.media.mit.edu) [8] is an online, multiagent consumer-to-consumer transaction system. Users who want to buy or sell an item create an agent, give it some strategic direction, and send it off into a centralized agent marketplace (see Figure 4). Kasbah agents proactively seek out potential buyers or sellers and negotiate with them on behalf of their owners. Each agent's goal is to complete an acceptable deal on behalf of its usersubject to a set of user-specified constraints, such as initial asking (or bidding) price, a lowest (or highest) acceptable price, a date by which to complete the transaction, and restrictions on which parties to negotiate with and how to change the price over time. Kasbah's agents automate much of the merchant-brokering and negotiation stages for both buyers and sellers.

Negotiation in Kasbah is straightforward. After buying agents and selling agents are matched, the only valid action in the negotiation protocol is for buying agents to offer a bid to selling agents with no restrictions on time or price. Selling agents respond with either a binding "yes" or "no." Given this protocol, Kasbah provides buyers with one of three negotiation strategies: anxious, cool-headed, and frugal-corresponding to a linear, quadratic, and exponential function respectively for increasing its bid for a product over time (similar functions exist for selling agents). The simplicity of these negotiation heuristics makes it intuitive for users to understand what their agents are doing in the marketplace. This understanding is important for user acceptance, as observed in a recent Media Lab experiment [8]. A larger Kasbah experiment now under way at MIT allows students to buy and sell books and music.

The Kasbah system also incorporates a trust and reputation mechanism called the "better business bureau." Upon completion of a transaction, both parties may rate how well their counterpart managed his or her half of the deal (such as for accuracy of product condition and completion of transaction). Kasbah agents use accumulated ratings to determine whether they should negotiate with agents whose owners fall below a user-specified reputation threshold. More details on the specific algorithms used in Kasbah's better business bureau are in [9]. Tete-a-Tete (ecommerce.media.mit.edu/tete-atete/) [10] provides a unique negotiation approach to retail sales. Unlike most other online negotiation systems that competitively negotiate over price, Tete-aTete's consumer-owned shopping agents and merchant-owned sales agents cooperatively negotiate across multiple terms of a transaction, including warranties, delivery times, service contracts, return policies, loan options, gift services, and other merchant value-added services. Based on bilateral argumentation [11], Tete-a-Tete's integrative negotiations comprise an exchange of XML-based

proposals, critiques, and counterproposals. For example, a shopping agent may receive proposals from multiple sales agents. Each one defines a complete product offering, including a product's configuration and price and the merchant's value-added services. The shopping agent evaluates and orders these proposals based on how well they satisfy its owner's preferences (expressed as multiattribute utilities) (see Figure 5). Shoppers dissatisfied with the proposals can critique them along one or more dimensions. The shopper agent broadcasts these preference changes to the sales agents that, in turn, use them to counterpropose better product offerings.

Tete-a-Tete considers product features and merchant features equally throughout negotiations to help the shopper simultaneously determine what to buy and whom to buy from. This integration of product and merchant brokering through integrative negotiations enables constraints on product features to influence the decision of whom to buy from. For example, only a certain merchant may provide a particular product configuration. Likewise, constraints on merchant features can influence the decision of what to buy. So, if no merchant can accommodate the overnight delivery of a specific product, an alternate product that can be delivered overnight may be deemed a better overall value.

Future Directions

Software agents are helping buyers and sellers combat information overload and expedite specific stages of the online buying process. Today's first-generation agent-mediated e-commerce systems are already creating new markets (such as low-cost consumer-to-consumer goods) and beginning to reduce transaction costs in a variety of business processes. The industries affected first are those dealing with perishables (such as travel, theater and concert tickets, and network bandwidth availability), and surplus inventory and commodities (such as gas, electricity, pencils, music, and books).

However, we still have a way to go before software agents transform the way companies conduct business. This change will occur as agent technologies mature to better manage ambiguous content, personalized preferences, complex goals, changing environments, and disconnected parties. The greatest changes may occur once standards are adopted and resolved to unambiguously and universally define goods and services [10], consumer and merchant profiles, valueadded services, secure payment mechanisms, and interbusiness electronic forms.

Looking even further into the future, agents will explore new types of transactions in the form of dynamic relationships among previously unknown parties. At the speed of bits, agents will strategically form and reform coalitions to bid on contracts and leverage economies of scale-in essence creating dynamic business partnerships that exist only as long as necessary. It is in this third-generation of agentmediated e-commerce that companies will be at their most agile, and marketplaces will approach perfect efficiency

Reference:
REFERENCES

Reference:

1. Maes, P. Agents that reduce work and information overload. Commun. ACM37, 7 (July 1994), 31-40.

2. Moukas, A., Guttman, R, and Maes, P. Agent-mediated electronic commerce: An MIT Media Laboratory perspective. In Proceedings of the International Conference on Electronic Commerce (Seoul, Korea, Apr. 6-9). ICEC, Seoul, 1998, pp. 9-15.

3. Terpsidis, I., Moukas, A., Pergioudakis, B., Doukidis, G., and Maes, P. The Potential of electronic commerce in reengineering consumer-retail relationships through intelligent agents. In Advances in Information Technologies: The Business Challenge, J.-Y. Roger, B. Stanford-Smith, and P. Kidd., Eds., IOS Press, Amsterdam, Denmark, 1997. 4. Shardanand, U., and Maes, P. Social information filtering: Algorithms for automating 'word of mouth.' In Proceedings of the Computer-Human Interaction Conference CHI95 (Denver, Colo., May 7-11). ACM Press, N.Y., pp. 210-217.

Reference:
5. Doorenbos, R., Etzioni, O., and Weld, D. A scalable comparison-shopping agent for the World-Wide Web. In Proceedings of the First International Conference on Autonomous Agents 97 (Marina del Rey, Calif., Feb. 5-8). ACM Press, N.Y., 1997, pp. 3948.

6. Rodriquez, J., Noriega, P., Sierra, C., and Padget, J. FM96.5: A Javabased electronic auction house. In Proceedings of the Second International Conference on the Practical Application of Intelligent Agents and Multi-Agent Technology PAAM'97 (London, U.K., Apr.). Practical Application Company, London, 1997.

7. Axelrod, R. The Evolution of Cooperation. Harper Collins, N.Y., 1984. 8. Chavez, A., Dreilinger, D., Guttman, IL, and Maes, P. A real-life experiment in creating an agent marketplace. In Proceedings of the Second International Conference on the Practical Application of Intelligent Agents and Multi-Agent Technology PAAM97 (London, U.K., Apr.). Practical Application Company, London, 1997.

Reference:

9. Zacharia, G., Moukas, A., and Maes, P. Collaborative reputation mechanisms in electronic marketplaces. In Proceedings of the HICSS-99 Conference, Electronic Commerce Minitrack (Maui, Hawaii, Jan. 5-9). IEEE Computer Society, 1999.

10. Guttman, R., and Maes, P. Agent-mediated integrative negotiation for retail electronic commerce. In Proceedings of the Workshop on Agent-Mediated Electronic Trading AMET 98 (Minneapolis, May 1998). 11. Parsons, S., Sierra, C., and Jennings, N. Agents that reason and negotiate by arguing. J. Log. Comput.

Author Affiliation:

PATTIE MAES (pattie@media.mit.edu) is an associate professor in MITs Media Laboratory where she founded and directs the Software Agents Group.

ROBERT H. GUTTMAN (guttman@media.mit.edu) is a cofounder of Frictionless Commerce, Inc., a start-up building the next generation of shopping advisory solutions for retail e-commèrce.

ALEXANDROS G. MOUKAS (moux@media.mit.edu) is a cofounder of Frictionless Commerce, Inc., an AT&T Fellow, and a doctoral candidate in MIT Media Laboratory's Software Agents Group (on leave).

GEOGRAPHIC NAMES: US

DESCRIPTORS: Electronic commerce; Market potential; Intelligent agent; Internet; World Wide Web; Buy sell agreements
CLASSIFICATION CODES: 5250 (CN=Telecommunications systems); 9190 (CN=United States); 7300 (CN=Sales & selling)
?